But this difficulty in conceiving that mind or soul can play a part in the world of matter by acting upon masses in the brain exists only for those who persist in holding the untenable hypothesis that all energy is kinetic energy, is the motion of matter. This has proved, of course, an excellent working hypothesis, but that it is true of all forms of energy is nothing more than a pious hope. Yet it is the definition of energy in these terms (tacitly or explicitly) that perpetuates the ancient difficulty of conceiving the relations of mind and body, and it is the persistent adherence to this conception that, on the one hand, has landed so many minds in the absurdities of psychophysical parallelism, and, on the other hand, drives so many others to refuse a general acceptance of the law of conservation of energy, and to believe in an activity of the soul unconditioned by the past, a belief which destroys the rational basis of morals and renders a science of history and of society impossible.

To me it seems that this fundamental problem can only be properly stated when we cease to regard matter as the ultimate physical reality, when with Prof. W. Ostwald we say, " Matter is no longer present for us as a primary conception; it arises as a secondary phenomenon through the constant coexistence of certain forms of energy. We shall therefore have to frame the question in a new form—How are psychical phenomena related to the energy-concept? " and " that in the case of psychical processes we have to do with the rise and the transformation of a special kind of energy, which we, in order to be able to speak of it, will name provisionally psychical energy (geistige Energie)." [1]

Haslemere, April 26. W. McDOUGALL.

I HAVE pleasure in answering Mr. McDougall's questions so far as they are addressed to me.

In the first place I have not presumed to say how psychic control actually is exercised; but, in contradistinction to those who hold that control or guidance is impossible without the generation or introduction of fresh energy, I have pointed out that very simple and familiar mechanical arrangements do constantly exert guidance without doing any work; for instance, a line of rails.

Mr. McDougall thereupon asks me whether the line of rails is really quiescent, whether it is not subjected to an opposite acceleration. I reply yes, but what of that? The yield of rail is infinitesimal, but whatever its magnitude it is such as to make the guidance less effective, not more; it is a passive yield to pressure, not an active exertion of energetic work-performing force in the direction of motion or of change of motion. The recoil of a gun is of no assistance in propelling a bullet.

In so far as the rails yield to the train as it enters Euston by a curve, they guide it not to Euston as it was, but to a slightly shifted destination. No matter, they guide it, and they have had no energetic or propelling power whatever.

He asks me further if I fully admit the principle of universal equal opposite reaction, and the consequent conservation of momentum.

Certainly I do; but I do not admit the (as I think) mistaken use Prof. James Ward makes of the principle in the sentence which he refers to.

Mr. McDougall seems to overlook the fact that kinetic energy is independent of direction. Whether a thing be moving north or south or east or west its energy depends on mass and speed alone. To change the speed, work is necessary; no work is needed to alter the direction. Perhaps it may be a help to him, though it is not really important in this connection, if I say that great momentum does not necessarily imply great energy. The momentum of a recoiling gun or earth is equal to that of the projectile, but the energy of the projectile is enormous in comparison with the energy of recoil.

He asks me for an example of " a change of direction of motion of any mass produced without expenditure of energy or opposite change of direction of motion of other mass or masses." But the two things are not the same. An instance of change of direction of motion without expenditure of energy is afforded by the instances we have already taken, or by any perfectly elastic rebound—that of a comet from the sun, for instance. Undoubtedly the sun thereby acquires an equal opposite momentum, but what of that? The modicum of energy in this momentum is infinitesimal, for one thing, and for another it comes from the comet, not from the sun; it renders the rebound less efficient, not more; it is no supply of energy from the central practically stationary mass. The same thing is true of a ball whirling on a string round a pole. When a boy holds the string in an active hand, it is quite easy and usual to do a little work by moving the hand a quadrant in advance of the ball, and thus to maintain, or even increase, its energy; but the force so exerted by a hand is not purely radial, it has a tangential component, and this part of it is effectively propulsive. An energetic, not a passive, centre is needed for that.

Coming to another part of his letter; his illustration of a great display of available energy being brought about by the reversal of motion of one of two similarly flying bodies, suffers from the confusion of energy with available energy. The flying of air molecules, for instance, is in every direction, sometimes so as to be able to collide, sometimes not, but their energy is quite independent of these directional circumstances. As Dr. Hobson truly says in your issue of April 30, " the principle of energy, if applied to even the simplest dynamical system which is possessed of more than one degree of freedom, is, taken by itself, wholly insufficient for the determination of the motion of such system." That is one part of my contention, technically stated. In so far as a question of absolute velocity seems involved in the energy of a single isolated flying mass, I might refer to a discussion of that aspect of the matter in the *Philosophical Magazine* for October, 1898.

In conclusion, I perceive that Mr. McDougall, like some other philosophers, hopes to jump the admitted difficulties of psychophysical interaction by ignoring " matter " altogether and taking refuge in " energy " alone. I venture to predict that those who attempt this will find that though they may wander in dimness for a time, and may cultivate an unawareness of difficulties by failing to see them distinctly, they will not derive any ultimate satisfaction from the blindfolding; nor do I think that they will be well advised to transplant the definite physical term " energy," even though prefixed by a special adjective such as *geistige*, in order to denominate what is probably a perfectly distinct psychical entity with laws of its own. OLIVER LODGE.

THOSE of your readers who have been interested by Sir Oliver Lodge's article printed in NATURE, April 23, on the " Interaction Between the Mental and Material Aspects of Things," may be glad to be referred to Thomas Solly's essay on the Will, published in 1856.

The suggestion of Solly is that every act of the will is simply a guidance of *mental* activity, infinitesimal, indeed, in its amount in each individual act, but such as to influence, not the external world, but the character of the individual exercising it, so that the same external stimulus operates after each successive act of the will on an individual whose character has been changed by that act, whence same stimulus is no longer necessarily the same motive. By thus regarding each act of the will as a " self-determination of the subject," the acts of choice or guidance are assumed to take place in a region of activity about which we have no physical information whatever, and the interactions of material things are left absolutely untouched.

The significance of the suggestion is made extremely clear in Solly's chapter on " Liberty, a Self-Determination of the Subject," and in subsequent chapters, by means of very happily chosen geometrical illustrations.

Mohuns, Tavistock, April 26. A. M. WORTHINGTON.

Mendel's Principles of Heredity in Mice.

THE issues raised in the case of these mice are as yet of such a simple and familiar kind that the source of Prof. Weldon's difficulty is not easy to surmise. When a gamete G bearing albino and pink-eye meets a gamete G′ bearing coloured coat (in this case fawn) and pink-eye, a heterozygote GG′ was produced, with dark eyes and coloured coat. Such hybrids, as the experiments proved, gave off equal

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[1] " Vorlesungen über Naturphilosophie " (Leipzig, 1902).

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numbers of gametes G, bearing albino with pink-eye, and G' bearing colour with pink-eye. Consequently from $GG' \times GG'$ we expect and obtain $GG + 2GG' + G'G'$; and from $GG' \times G$ equal numbers (approximately) of GG and GG'. So far, GG are pink-eyed albinos; GG' are dark-eyed with *some* colour in coat; $G'G'$ are pink-eyed, but with *some* colour in coat.

If we do not consider what *particular* colour GG' and $G'G'$ will have, we may treat all gametes G' as identical. But after crossing with albino such a condition would be unusual. The colour brought in by the original G' is generally in part resolved, and various sorts of G' gametes are formed, viz. aG', bG', cG', $abcG'$, &c. Therefore when the hybrids breed together there will be GG' zygotes of several colours, viz. $G.aG'$, $G.bG'$, $G.cG'$, &c.; also $G'G'$ zygotes of several colours, viz. $aG'.aG'$, $aG'.bG'$, &c. Each combination will have its appropriate colour and frequency, though (if the regularity be maintained) all GG' will have dark eyes and *some* colour, and all $G'G'$ pink eyes and *some* colour. But as the hybrid produces G gametes equal in number to the various G' gametes collectively, $GG' \times GG'$ will give on an average one albino in four offspring (experiment gave nine in thirty-seven); and there is no question of one in nine. We are only concerned with *one* hypothesis (that I have set forth in "Mendel's Principles of Heredity," p. 29), and with this hypothesis the published facts are in admirable agreement.

Heterogeneous offspring from crossing two seemingly pure races may seem to Prof. Weldon an "amazing" phenomenon, but it is one with which the breeder early becomes familiar. Even albinos need not be pure or their gametes homogeneous in characters other than albinism.

Grantchester, Cambridge, May 1. W. Bateson.

Mr. Bateson reconciles his statements in Nature of March 19 and April 23 by explaining that in his first letter, when he describes certain mice as of constitution $G'G'$, he is deliberately denoting a whole series of different gametes by the same name.

The suggested heterogeneity among the gametes of pure albinos is now said to affect characters other than albinism, and is therefore wholly irrelevant. The avowed vagueness in the use of the symbol G' makes it uncertain whether the fawn-and-white mice are now supposed to produce gametes of different character (with regard to coat-colour and eye-colour) or not. If the gametes of all the fawn-and-white mice used are similar, then all hybrids between these and albino mice are of similar constitution, and the fact that some are yellow, some grey, and some black is left unaccounted for. If the fawn-and-white mice produce even three kinds of gametes, G'_1, G'_2 and G'_3, then on crossing with albinos the hybrids GG'_1, GG'_2 and GG'_3 may be of different coat-colour; but since the fawn-and-white mice always breed true to colour when paired *inter se*, it surely follows that the combinations $G'_1G'_1$, $G'_1G'_2$, $G'_2G'_2$, &c., which arise from such unions (some homozygotes and some heterozygotes) give rise to mice of similar colour. It is this consequence of heterogeneity in a pure-breeding race which seems to me amazing.

In assuming that coat-colour is resolved into simpler elements when hybrids form their gametes, Mr. Bateson follows Mendel; but in such cases Mendel assumes that all the various kinds of gametes, produced by the hybrid, occur with equal frequency, and Mr. Bateson has elsewhere attempted to bring this assumption into relation with the phenomena of cell-division ("Mendel's Principles of Heredity," p. 30). In trying to fit Mr. Darbishire's facts by a Mendelian formula, Mr. Bateson abandons this hypothesis; he now says that a hybrid mouse produces (1) a series of different kinds of colour-bearing gametes, and (2) a number of gametes bearing the characters white coat and pink eye, *equal to the sum of all the other kinds of gametes together*. This departure from Mendel's hypothesis is masked in Mr. Bateson's first letter by the simple device of calling the whole series of different colour-bearing gametes by the same name G'.

Mendel's own view of the way in which compound characters behave gives a maximum possibility of one pure recessive albino among sixteen offspring of hybrids; a non-Mendelian view, lately put forward by Mr. Bateson in another case of colour-resolution (*Proc.* Camb. Phil. Soc., vol. xii. p. 52), gives a maximum of one in *nine*; the view he now suggests for mice gives one in *four*. By modifying first one and then another of Mendel's statements, his name is made to shelter almost any hypothesis, and almost any experimental test is evaded.

In the next number of *Biometrika* Mr. Darbishire will publish a series of new results, which have an important bearing on the application of Mendel's "principles" to his mice. Until these new facts are available, I do not think further discussion will be profitable, and therefore I do not propose to continue this correspondence.

Oxford May 6. W. F. R. Weldon.

[This correspondence must now cease.—Ed.]

INTERNATIONAL METEOROLOGICAL COMMITTEE.

The International Meteorological Committee appointed by the Paris Congress of 1896 in succession to those appointed by previous congresses, commencing with the Vienna Congress of 1873, will meet this year at Southport during the session of the British Association, September 9 to 16. The committee held a single meeting in the room at the top of the Eiffel Tower in 1900; its last normal session was at St. Petersburg in 1899. It has not met in England for twenty-six years. The original "permanent" committee was appointed by the Vienna Congress in 1873, and consisted of six members under the presidency of Buys Ballot; its successor now numbers seventeen members, representing a large number of the official meteorological organisations of the world. Prof. Mascart, of the Bureau Central Météorologique of France, is president, and Prof. H. H. Hildebrandsson, of the Royal Observatory of Upsala, is secretary, having been elected to that office on the resignation of Mr. Scott, who was secretary from 1874 (the Utrecht meeting) until the close of 1899. The other members are Prof. von Bezold (German Empire), Prof. Billwiller (Switzerland), Captain Chaves (Azores, Portugal), W. Davis (Argentine), Sir J. Eliot, K.C.I.E. (India), Prof. S. Hepites (Roumania), Prof. H. Mohn (Norway), Prof. Willis L. Moore (United States), Prof. L. Palazzo (Italy), Prof. Paulsen (Denmark), Prof. J. M. Pernter (Austria), Mr. H. C. Russell, C.M.G. (Australia), General Rykatcheff (Russia), Mr. W. N. Shaw (Great Britain), and Prof. H. Snellen (Holland).

The functions of the committee are to discuss meteorological questions of international interest and formulate proposals for international cooperation in connection therewith. The deliberations have an official character in virtue of the committee being appointed by a congress of representatives delegated in response to an official invitation of one or other of the European Governments, but the committee has no executive authority. It has been the practice for the committee to appoint from time to time various "commissions" or subcommittees to prepare reports upon questions that require preliminary discussion. The members of these subcommittees are not necessarily members of the international committee. They meet from time to time on the invitation of their respective chairmen, and opportunity is often taken of the occasion of the meeting of a subcommittee to obtain more general discussion by inviting other persons interested in the special subjects to take part in the proceedings, and sometimes to become members of the subcommittee. There are at present five subcommittees, constituted as follows:—

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